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Simulium (*Gomphostilbia*) *chiangdaoense* sp. nov. (Diptera: Simuliidae) from northern Thailand

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Abstract: *Simulium* (*Gomphostilbia*) *chiangdaoense* sp. nov. is described from adult and pupal specimens collected from northern Thailand. This new species is assigned to the *ceylonicum* species-group and is characterized by the cocoon with an extraordinarily elongate anterodorsal projection as well as the almost fully-haired male subcosta.

Key words: *Simulium*, black fly, Simuliidae, Thailand, description

In Thailand, the *ceylonicum* species-group, characterized by an enlarged male hind basitarsus (Takaoka and Davies, 1996), is one of the richest groups in terms of species diversity within the subgenus *Simulium* (*Gomphostilbia*), as evidenced by the presence of as many as 12 members, i.e., seven named species and five unnamed species (Adler and Crosskey, 2009). Among these 12 species, two species, *S.* (*G.*) *inthanonense* Takaoka and Suzuki and *S.* (*G.*) *udomi* Takaoka and Choochote, are readily distinguished in the pupal stage from the other ten species by having the cocoon with an anterodorsal projection (Takaoka and Suzuki, 1984; Takaoka and Choochote, 2006).

During recent surveys of larvae and pupae of black flies in Doi Chiang Dao and Doi Inthanon National Parks, northern Thailand, we collected one new species of the *ceylonicum* species-group, which has an elongate anterodorsal projection of the cocoon but apparently differs from *S.* (*G.*) *inthanonense* and *S.* (*G.*) *udomi* by certain morphological characteristics as noted below.

This new species is here described on the basis of female, male and pupal specimens. All the adult specimens examined were reared from pupae.

The terms for morphological features used here follow those of Takaoka (2003). Holotype and paratype specimens of the new species are deposited at the Entomology Section, Queen Sirikit Botanic Garden, Chiang Mai, Thailand.

Simulium (*Gomphostilbia*) *chiangdaoense* sp. nov.

DESCRIPTION. **Female**. Body length 2.5 mm. ***Head***. Slightly narrower than width of thorax. Frons brownish-black, slightly shiny at certain angle of light, densely covered with whitish-yellow recumbent short hairs interspersed with several dark simple longer hairs along each lateral margin; frontal ratio 1.88 : 1.00 : 2.65; frons-head ratio 1.00 : 4.71. Frontoocular area (Fig. 1A) well de veloped, narrow, directed dorsolaterally. Clypeus brownish-black, densely covered with whitish-yellow recumbent short hairs interspersed with 7–9 dark longer hairs on each side of lower 2/3. Labrum 0.61 times as long as clypeus. Antenna composed of scape, pedicel and 9 flagellomeres, dark brown to brownish-black

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except scape, pedicel and base of 1st flagellomere yellow. Maxillary palp composed of 5 segments, medium to dark brown, proportional lengths of 3rd, 4th, and 5th segments 1.00 : 1.25 : 2.89; 3rd segment (Fig. 1B) swollen; sensory vesicle (Fig. 1B) oblong, 0.36 times as long as 3rd segment, with medium-sized opening medially. Maxillary lacinia with 12–14 inner and 15–17 outer teeth. Mandible (Fig. 1C) with 25 inner and 7 or 8 outer teeth (though outer margin without distinct teeth near apex). Cibarium (Fig. 1D) medially forming round sclerotized plate folded forward from posterior margin, and with moderately sclerotized medial longitudinal ridge. ***Thorax***. Scutum bro wnish-black (except anterior calli yellow to ocherous), slightly shiny, thinly grayish-white, moderately covered with whitish-yellow recumbent short hairs; no longitudinal vitta discernible. Scutellum medium brown, covered with whitish-yellow short hairs as well as dark brown long upright hairs along posterior margin. Postnotum dark brown, bare, thinly grayish-white pruinose when viewed at certain angle of light. Pleural membrane bare. Katepisternum dark brown, longer than deep, moderately covered with dark brown short hairs intermixed with yellowish-white hairs. ***Legs***. Foreleg: coxa whitish-yellow; trochanter yellow with light brown portions; femur light to medium brown; tibia white to yellowish-white on basal 7/10 and brownish-black on apical 3/10; tarsus brownish-black, with moderate dorsal hair crest; basitarsus moderately dilated, 6.5 times as long as its greatest width. Midleg: coxa medium brown except posterolateral surface dark brown; trochanter yellow; femur light to medium brown except base yellowish; tibia dark brown except basal 2/5 (up to basal 1/2 on posterior surface) white; tarsus dark brown except basal 1/3 light brown. Hind leg: coxa light brown; trochanter yellow; femur light to medium brown with base yellow and apical cap dark brown; tibia (Fig. 1E) white to yellowish-white except little less than apical 1/2 light brown to brownish-black; tarsus dark brown except little more than basal 2/3 of basitarsus and basal 1/2 of 2nd tarsomere white to yellowish-white; basitarsus (Fig. 1F) narrow, nearly pa rallel-sided except apical 1/2 slightly tapered toward apex, 6.23 times as long as wide, and 0.67 and 0.56 times as wide as greatest widths of tibia and femur, respectively. Calcipala (Fig. 1F) 1.22 times as long as wide, and 0.60 times as wide as greatest width of basitarsus. Pedisulcus (Fig. 1F) well developed. Claw (Fig. 1G) with large basal tooth 0.47 times as long as claw. ***Wing***. Length 2.3 mm. Costa with dark brown spinules as well as dark brown hairs except patch of yellow hairs at base. Subcosta with dark hairs except near apex bare. Hair tuft on stem vein yellow. Basal portion of radius fully haired; R_1 with dark brown spinules and dark brown hairs; R_2 with dark brown hairs only. Basal cell absent. ***Abdomen***. Basal scale light brown, with fringe of whitish-yellow hairs. Dorsal surface of abdomen light to medium brown except basal 1/2 of segment 2 whitish-yellow and tergites 3–5 dark brown, moderately covered with dark brown stout hairs intermixed with paler short fine hairs; tergites of segments 2 and 6–9 wide and shiny; ventral surface of segments 2–4 whitish-yellow, and those of segments 5–7 medium yellow to light brown, and that of segment 8 dark brown; sternal plate on segment 7 undeveloped. ***Genitalia***. Ster nite 8 (Fig. 1H) bare medially, with 14–17 medium-long to long hairs and few short setae on each side. Ovipositor valves (Fig. 1H) triangular, with round medioposterior corners, thin, membranous, moderately covered with microsetae interspersed with 0–1 short seta; inner margins slightly sinuous, moderately sclerotized, and moderately separated from each other. Genital fork (Fig. 1I) of usual inverted-Y form, with arms of moderate width; arm moderately folded medially. Paraproct in ventral view (Fig. 1J) nearly triangular, pointed me dially, and with 3 or 4 sensilla on anteromedial surface; paraproct in lateral view (Fig. 1K) somewhat produced ventrally, with 15–18 medium-long to long hairs on ventral and lateral surface. Cercus in lateral view (Fig. 1K) short, rounded posteriorly, nearly half as long as wide. Spermatheca (Fig. 1L) ellipsoidal, 1.39 times as long as wide, well sclerotized except duct and small area near juncture with duct unsclerotized, and with many fissures on surface; internal setae absent; both accessory ducts slender, subequal in diameter to major one.

Male. Body length 2.7 mm. ***Head***. Slightly narrower than thorax. Upper eye consisting of 13 or 14 vertical columns and 15 or 16 horizontal rows of large facets. Face dark brown, white pruinose. Clypeus dark brown, densely covered with yellow short to medium-long

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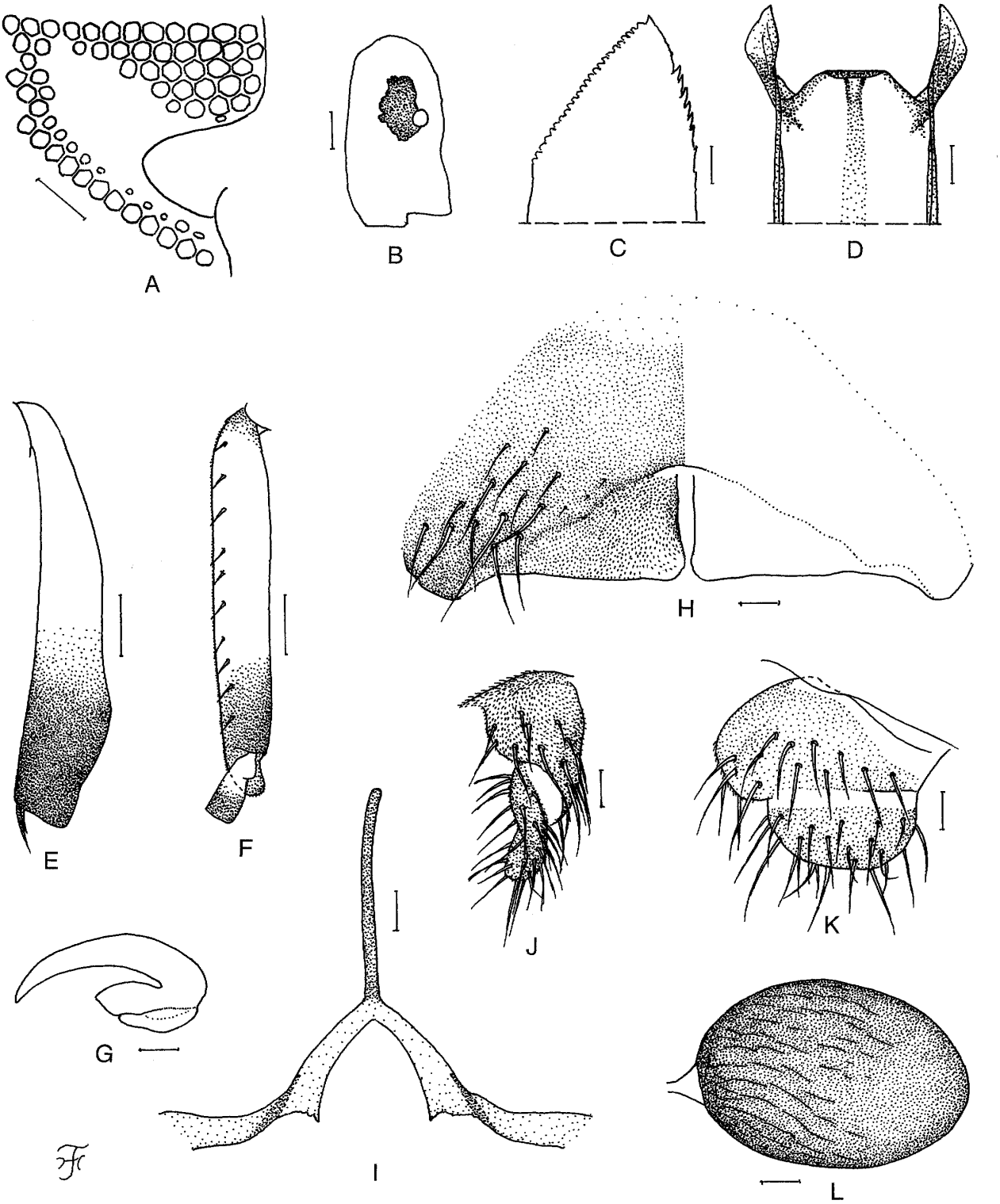

Fig. 1. Female of *Simulium* (*Gomphostilbia*) *chiangdaoense* sp. nov. A, fronto-ocular area (right side); B, 3rd segment of maxillary palp with sensory vesicle (right side; front view); C, tip of mandible; D, cibarium; E, hind tibia (left side; outer view); F, hind basitarsus and 2nd tarsomere showing calcipala and pedisulcus (left side; outer view); G, claw; H, 8th sternite and ovipositor valves (ventral view); I, genital fork (ventral view); J and K, paraprocts and cerci (left side; J, ventral view; K, lateral view); L, spermatheca (lateral view). Scale bars. 0.1 mm for E and F; 0.04 mm for A; 0.02 mm for B, D and H–L; 0.01 mm for C and G.

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hairs (mostly directed upwards) interspersed with several dark brown simple longer hairs near lower margin. Antenna composed of scape, pedicel and 9 flagellomeres, dark brown to brownish-black except scape, pedicel and base of 1st flagellomere yellow (though apical 1/2 of pedicel dark yellow to light brown in 1 male); 1st flagellomere elongate, 1.89 times as long as 2nd one. Maxillary palp with 5 segments, light brown, proportional lengths of 3 rd, 4th, and 5th segments 1.00 : 1.20 : 3.06; sensory vesicle (Fig. 2A) nearly globular, small, 0.16 times as long as 3rd segment, and with small opening. ***Thorax***. Nearly as in female except fine hairs on scutum, scutellum and katepisternum yellow. ***Legs***. Foreleg: coxa whitish-yellow; trochanter yellow with light brown portions; femur light to medium brown; tibia white to yellowish-white on basal 3/5 and brownish-black on apical 2/5; tarsus brownish-black, with moderate dorsal hair crest; basitarsus moderately dilated, 8.22 times as long as its greatest width. Midleg: coxa medium brown except posterolateral surface dark brown; trochanter yellow, with light brown portions; femur light to medium brown; tibia dark brown except basal 1/3 white; tarsus dark brown except basal 1/3 dark yellow to light brown. Hind leg: coxa light brown; trochanter yellow; femur medium brown with base yellow and apical cap dark brown; tibia (Fig. 2B) dark brown to brownish-black except slightly more than basal 2/5 yellowish-white; tarsus dark brown except basal 1/3 to 2/5 of basitarsus dark yellow and basal 1/2 of 2nd tarsomere yellow; basitarsus (Fig. 2C) enlarged, 3.64 times as long as wide, and 1.00 and 1.24 times as wide as greatest widths of tibia and femur, respectively; calcipala small, nearly as long as wide, and 0.30 times as wide as greatest width of basitarsus. ***Wing***. Length and other characters as in female including almost fully-haired subcosta. ***Abdomen***. Basal scale medium brown with fringe of light brown hairs. Dorsal surface of abdomen light brown to brownish-black, densely covered with dark brown short to long hairs intermixed with pale fine short hairs; segments 2 and 5–7 each with pair of shiny dorsolateral or lateral patches, of which those on segment 2 broadly connected in middle to each other; ventral surface of segments 2–4 yellowish-white except sternites 3 and 4 medium brown, those of other segments light to medium brown except sternites medium to dark brown. ***Genitalia***. Coxite in ventral view (Fig. 2D) nearly rectangular, 2.38 times as long as wide; coxite in ventrolateral view (Fig. 2E) nearly quadrate, tapered posteriorly, moderately covered with long stout hairs except narrow bare area along anterior margin; coxite in medial view (Fig. 2G) narrow. Style in ventral view (Fig. 2D) slender, nearly parallel-sided, 0.78 times as long as coxite, gently bent inward, with apical spine; style in ventrolateral view (Fig. 2F) gradually tapered toward apex, with blunt apex; style in medial view (Fig. 2G) slightly tapered toward apex, gently curved dorsally. Ventral plate in ventral view (Fig. 2D), transverse, 0.49 times as long as wide, with anterior margin produced anteromedially, posterior and lateral margins slightly convex medially, and densely covered with microsetae on ventral surface except near anterior margin bare; basal arms of moderate length, somewhat divergent basally, then slightly convergent; ventral plate in lateral view (Fig. 2H) much produced ventrally; ventral plate in end view (Fig. 2I) rounded ventrally and densely covered with microsetae on posterior surface. Median sclerite (Fig. 2J) thin, plate-like, wide. Paramere (Fig. 2K) of moderate size, with 4 distinct hooks and few small ones. Aedeagal membrane (Fig. 2K) moderately setose. Ventral surface of 10th abdominal segment thinly sclerotized anteriorly, without distinct hairs near posterior margin on each side. Cercus (Fig. 2L, M) rounded, encircled with 13–16 hairs.

Pupa. Body length 2.7–3.0 mm. ***Head***. Integument (Fig. 3A) dark yellow, moderately covered with round tubercles; antennal sheath normal, with no spinous projection, and without tubercle; face with pair of simple very long trichomes with coiled apex, frons with 2 (rarely 3) pairs of simple very long trichomes with uncoiled apex; 2 frontal trichomes on each side arising close together, subequal in length and thickness to each other and slightly longer and thinner than facial one. ***Thorax***. Integument dark yellow, moderately covered with round tubercles, with 3 pairs of simple very long trichomes with coiled apex dorsomedially, with 2 pairs of simple very long trichomes (1 with coiled apex, 1 with uncoiled apex) anterolaterally, with pair of simple medium-long or long trichomes with coiled apex posterolaterally, and with 3 pairs of simple trichomes (1 long and with coiled apex, 2 short

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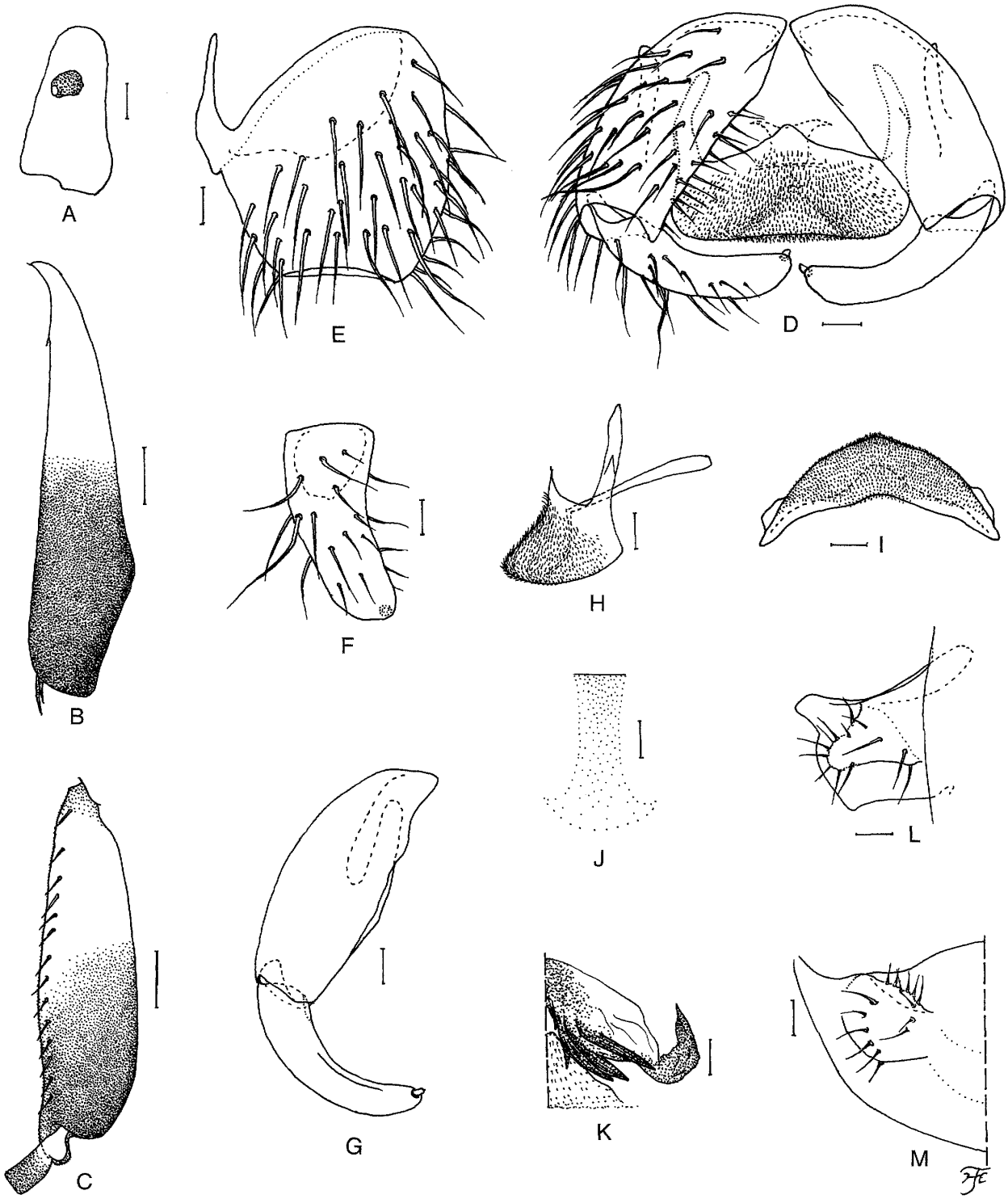

Fig. 2. Male of *Simulium* (*Gomphostilbia*) *chiangdaoense* sp. nov. A, 3rd segment of maxillary palp with sensory vesicle (left side; front view); B, hind tibia (left side; outer view); C, hind basitarsus and 2nd tarsomere showing calcipala and pedisulcus (left side; outer view); D, coxites, styles and ventral plate (ventral view); E, coxite (right side; ventrolateral view); F, style (right side; ventrolateral view); G, coxite and style (right side; medial view); H, ventral plate and median sclerite (lateral view); I, ventral plate (end view); J, median sclerite (end view); K, paramere and aedeagal membrane (left side; end view); L and M, cerci (L, left side and lateral view; M, right side and end view). Scale bars. 0.1 mm for B and C; 0.02 mm for A and D–M.

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and with uncoiled apex) ventrolaterally. Gill (Fig. 3B, C) composed of 8 slender thread-like filaments, arranged in groups of [(1+2)+(1+2)]+2 filaments from dorsal to ventral, with somewhat swollen transparent organ ventrally (partially broken); upper and middle triplets lying close together, sharing short stalk which is slightly shorter than common basal stalk; each triplet with very short stalk, and composed of 1 individual and 2 paired filaments with very short stalk (or appearing to be composed of 3 individual filaments arising almost at same level, as shown in Fig. 3C); stalk of ventral paired filaments of medium length, thinner than interspiracular trunk, but thicker than primary stalk of middle triplet which is nearly as thick as that of dorsal triplet; stalk of upper triplet lying against that of lower pair at angle of 50–80 degree when viewed laterally; all filaments light brown, gradually tapered toward apex, different in length, i.e., ventral paired filaments (3.5–4.0 mm long) much longer and thicker than 6 other filaments of dorsal and middle triplets which are subequal in length (2.0–2.5 mm) and thickness to one another; cuticle of all filaments with distinct annular ridges and densely covered with minute tubercles of 2 different sizes, larger ones on ridges and smaller ones on interridge spaces. ***Abdomen***. Dorsally, segment 1 pale yellow, almost bare, with 1 simple slender medium-long seta on each side; segment 2 pale yellow, bare, with 1 simple slender medium-long seta (longer than that on segment 1) and 5 very short somewhat spinous setae, submedially on each side; segments 3 and 4 mostly transparent, each with 4 hooked spines and 1 very short somewhat spinous seta on each side; segment 5 lacking dorsal spine-combs; segments 6–9 each with distinct spine-combs in transverse row, together with comb-like groups of minute spines on each side; segment 9 with pair of distinct triangular terminal hooks somewhat extending laterally at base and having smooth or weakly to moderately crenulate outer margin (Fig. 3D–F). Ventrally, segment 4 with 2 short simple hooks and 2 simple slender very short setae on each side; segment 5 with pair of bifid or trifid hooks submedially and few very short simple slender setae on each side; segments 6 and 7 each with pair of bifid inner and simple outer hooks somewhat spaced from each other and few very short simple slender setae on each side; segments 4–8 with comb-like groups of minute spines. Each side of segment 9 with 4 or 5 grapnel-like hooklets. ***Cocoon*** (Fig. 3G,H). Wall-pocket-shaped, thinly woven, widely extending ventrolaterally, having elongate anterodorsal projection nearly pa rallel-sided or gradually widened or narrowed toward apex, often with shallow to deep incision anteromedially (Fig. 3I, J); posterior 1/2 with floor moderately woven; individual threads visible or not; 3.8–4.1 mm long by 3.2–3.6 mm wide.

Mature larva. Unknown.

TYPE SPECIMENS. Holotype female together with associated pupal exuviae and cocoon (in ethanol), collected from a small stream (width 0.2–1.0 m, shaded, water temperature 19℃, altitude 1,560 m) slowly flowing in a natural forest, Pa Kea Station, Doi Chiang Dao, Chiang Mai Province, Thailand, 23. V. 2009, W. Srisuka, W. Choochote, Y. Otsuka, A. Saeung, and H. Takaoka. Paratypes: 2 males and 1 pupal exuviae, same data as those of holotype; 2 females and 1 pupa, same locality as that of holotype, 27. IV. 2009, W. Srisuka; 10 females and 10 males, collected from a stream (width 1.2 m, shaded, water temperature 19℃, altitude 1,667 m) slowly flowing in a natural forest, Doi Inthanon National Park, Chiang Mai Province, Thailand, 24. VI. 2009, W. Srisuka and A. Saeung.

ECOLOGICAL NOTES. The pupae of this new species were taken from trailing grass leaves and fallen dead leaves in streams. Associated species were an undescribed species of *S.* (*G.*) *ceylonicum* species-group, *S.* (*Simulium*) *doipuiense* Takaoka and Choochote and *S.* (*S.*) *yuphae* Takaoka and Choochote in Doi Chiang Dao, and two undescribed species of *S.* (*G.*) *ceylonicum* species-group, *S.* (*G.*) *inthanonense* Takaoka and Suzuki, *S.* (*S.*) *fenestratum* Edwards and *S.* (*Nevermannia*) *feuerborni* Edwards in Doi Inthanon National Park.

ETYMOLOGY. The species name *chiangdaoense* refers to the name of the

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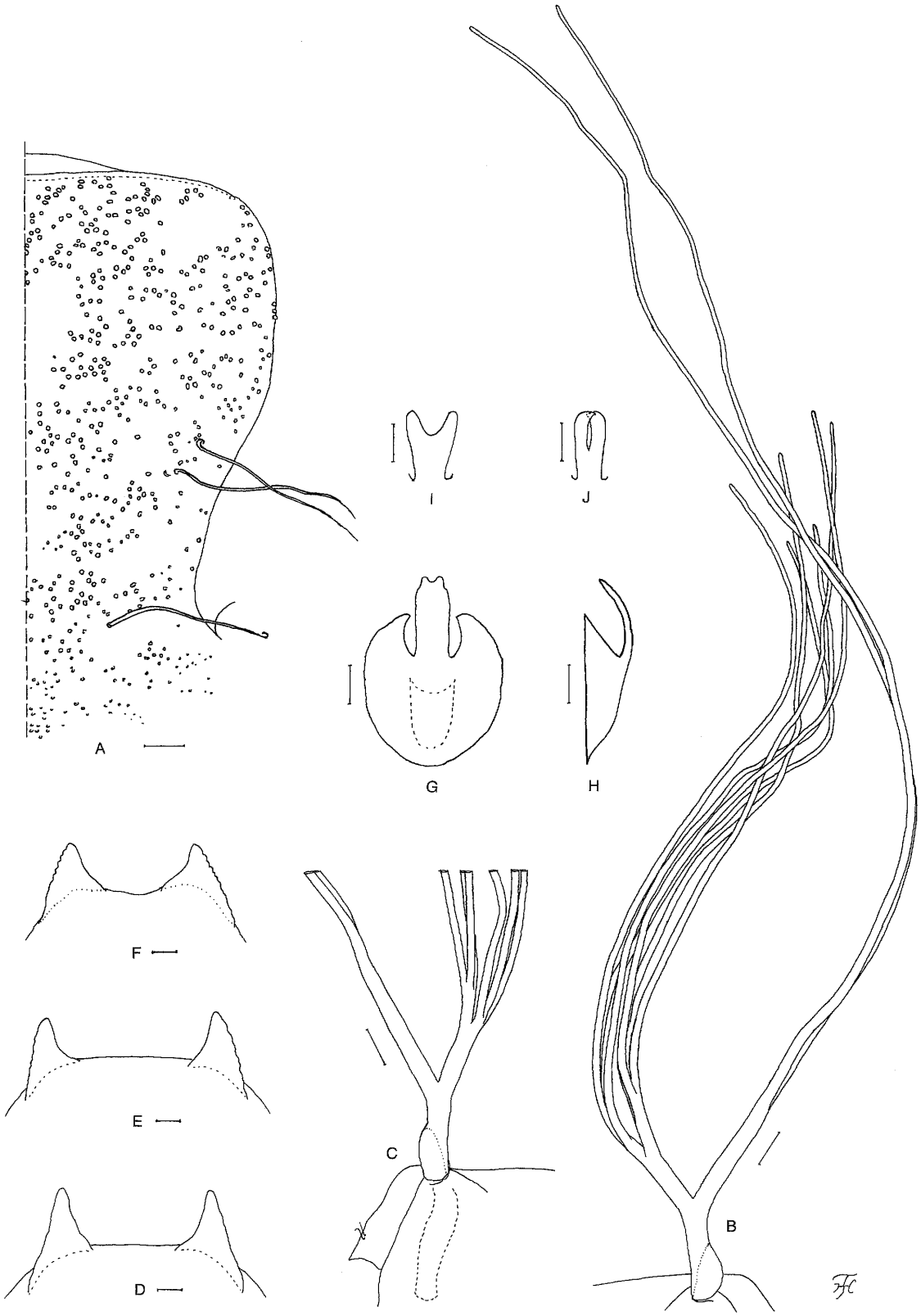

Fig. 3. Pupa of *Simulium* (*Gomphostilbia*) *chiangdaoense* sp. nov. A, frons and portion of face (left half); B, gill filaments (right side; outer view); C, basal portion of gill and anterior part of thorax showing interspiracular trunk (left side; outer view); D, terminal hooks with smooth outer margin (end view); E and F, terminal hooks with weakly to moderately crenulate outer margin (end view); G and H, cocoons (G, dorsal view; H, lateral view); I and J, anterodorsal projections with shallow to deep incision medially (dorsal view). Scale bars. 1.0 mm for G–J; 0.1 mm for B and C; 0.04 mm for A; 0.01 mm for D–F.

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mountain, Chiang Dao, where this new species was first collected.

REMARKS. *Simulium* (*G.*) *chiangdaoense* sp. nov. is readily assigned to the *ceylonicum* species-group within the subgenus *Gomphostilbia* by having the enlarged male hind basitarsus (Fig. 2C). This new species is distinctive among *Gomphostilbia* species in that it has the cocoon with a very long anterodorsal projection (Fig. 3G, H). Such an elongate anterodorsal projection of the cocoon has been reported in *S.* (*G.*) *udomi*, which was described from a single male reared from a pupa collected from Nan Province, Thailand (Takaoka and Choochote, 2006).

Interestingly, the male of this new species is very similar to that of *S.* (*G.*) *udomi* (Takaoka and Choochote, 2006) in many characters including the number of vertical columns and horizontal rows of large upper-eye facets, the almost fully-haired subcosta, the slender fore basitarsus, the shape and size of the hind basitarsus, the shape of the genitalia. However, there is a clear difference in the number of the pupal gill filaments (eight in this new species vs. six in *S.* (*G.*) *udomi*).

This new species is readily distinguished from *S.* (*G.*) *inthanonense* (Takaoka and Suzuki, 1984) in the female and male by the color of the tuft hairs on the stem vein of the wing (yellow vs. dark brown), in the female by the relative size of the sensory vesicle to the third maxillary palpal segment (medium-sized vs. very large), and in the male by the number of vertical columns of the large upper-eye facets (13 or 14 vs. 16), in the pupa by the length of the anterodorsal projection of the cocoon (very long vs. medium-long).

The female of this new species is very similar to that of *S.* (*G.*) *asakoae* Takaoka and Davies (Takaoka and Davies, 1995), which has been reported to transmit an undescribed species of filariae in northern Thailand (Ishii et al., 2008). There are, however, slight differences in the color of the hind tibia which is yellowish-white on little more than the basal 1/2 in this new species and on the basal 2/3 in *S.* (*G.*) *asakoae*, and in the shape of the cibarium which has a slightly narrower anteriorly-folded plate in this new species (Fig. 1D).

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